AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY
Agriculture AL72-0000-0000

B. SECONDARY
Pests of animals

2. TITLE AND SUBTITLE
AID finds ways to control vampire bat

3. AUTHOR(S)
Rosenthal,J.E.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1972	6p.	ARC 632.649.R815

7. REFERENCE ORGANIZATION NAME AND ADDRESS
AID

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*
(In War on hunger,June,1972)

9. ABSTRACT

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-RAA-479	
12. DESCRIPTORS Bats,vampire Research	13. PROJECT NUMBER
	14. CONTRACT NUMBER AID/OPA
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Research Breakthrough

AID Finds Ways to Control Vampire Bat

AID RESEARCH

By Jerry E. Rosenthal

On the late, late show, the vampire bat when he isn't feasting on some beauty's blood at midnight, conveniently turns into a pasty faced, hollow-eyed grim-some zombie who wears a funereal full-dress suit and resides in a drafty, murky castle in a dank corner of Eastern Europe.

The truth is, the rabies-spreading vampire bat isn't all that melodramatic or versatile. He doesn't change his personality or appearance at all. He doesn't own a white tie or even a tail to go with his fur coat and skin wings. He lives in a cave, tunnel, abandoned mine or well anywhere between Central Mexico and Northern Argentina. The vampire bat belongs exclusively to the Western Hemisphere, not yet in the United States.

But there is some truth in the macabre fantasy. The vampire does dine on blood. That is his only food. He may not seek exclusively to sink his vicious looking incisors into a human neck, but he does perform his repulsive, nocturnal act on livestock and other animals. And, of course, he has been known to bite humans, mostly children. Unless the bat is carrying rabies, however, the bite is not fatal.

REPRINTED FROM THE JUNE 1972 ISSUE OF WAR ON HUNGER AGENCY FOR INTERNATIONAL DEVELOPMENT

A vampire bat in flight. The unique animal causes huge livestock losses in Latin America

PASA-RA(ID)-1-67

The *Desmodus rotundus,* one of three species of vampire bats, is a menace. As a rabies carrier, he is responsible for deaths of approximately one million head of cattle a year in Latin American countries. The cost of this and attendant losses is estimated by the United Nations Food and Agriculture Organization at $250 million per year.

In addition, cattle that do survive a bat's bite may suffer loss of blood, malnutrition, myiasis (a disease caused by maggots); provide less meat and milk, and risk infection from other diseases.

Horses also are victims, and not only due to rabies. There is evidence that vampire bats may carry the Venezuelan equine encephalomyelitis virus, and may be involved in the transmission cycle of the disease. In 1970-71 this virus killed thousands of horses in Mexico and Central America and threatened more in Southwest United States.

Until now, there seemed to be no effective, safe, ecologically sound way to control this unique and expanding scourge. Brazil has been conducting an expensive and time-consuming anti-rabies livestock vaccination program that is far from satisfactory. Venezuela has used toxic sprays. These killed the "bad" vampire bats, all right, but they also killed the "good" insect-eating bats and other beneficial animals. Vampire bats habitually return to the bites they inflict, and lethal salves on these bites have been tried, but with only moderate success, and with some potential danger to the affected livestock. Caves where the vampire bats dwell have been dynamited, smoked and gassed, but, as with sprays, such measure cause damage to the beneficial animals.

Trapping and shooting are impractical, as are hand nets. Trinidad farmers have tried screened enclosures, which, though expensive, work for small herds, but are impractical for range animals. Besides, this procedure merely displaces the bats, which will fly to other herds, or to other animals, for their sustenance. Because bats feed in the dark, some farmers in Mexico have tried hanging lanterns around the corrals. The bats, however, are smart. They learn to adjust to weak lights and will bite on the dark or shaded side of their victims. This method, like screening, does nothing to control the pest.

AID Sponsors Project

Now, there seems to be a way—two ways, in fact—to meet the challenge of the vampire bat.

In April, the Agency for International Development and the Fish and Wildlife Service of the Department of Interior announced that two procedures have been developed and tested that promise to provide safe, effective and economical control of vampire bats.

The methods were developed as part of a project carried out under an AID contract with the Department of Interior signed in 1967. Work actually started in 1968. Under the contract, AID is providing the financing; the Bureau of Sport Fisheries and Wildlife is using its expertise and facilities of the Denver Wildlife Research Center in Colorado to study the control of bats, rats and birds that damage livestock and crops. The research into the control of rats and noxious birds will continue. The bat research is phasing out this year, having achieved its objective.

Both the methods employ a blood anticoagulant—used for human heart patients—that is ingeniously combined with the peculiar and specialized physical makeup and behavior of the little three-inch, one-ounce flying mammal.

In one method, the anticoagulant is injected into the rumen, one of four stomach compartments of cattle.

A technician prepares to remove a vampire bat from a net.

Unique "batmobile" aids in the study of the vampire bat's ability to fly in utter darkness.

It is then absorbed into the blood stream of the bat's intended victim—cattle. The bat bites, laps the blood and the anticoagulant in the blood enters the bat's digestive system. Since he consumes such an enormous amount of blood, virtually his own weight every 24 hours, he can't tolerate the anticoagulant. The result, simply, is that the anticoagulant prevents clotting of the bat's blood, and the bat dies as a result of internal hemorrhaging within a few days. The anticoagulant in the cattle, however, disappears within approximately five days with no harmful residue.

In the other procedure, the anticoagulant is mixed with petroleum jelly, smeared on the backs of a few captured bats captured in fine nets near corraled or tethered cattle. They are then released to fly back to their cave and contaminate the rest of the bats in the roost. One such treatment of a few bats will usually eliminate the entire colony within two weeks.

Contributes to Ecology

In announcing the breakthrough, AID Administrator John A. Hannah stressed that control of vampire bats would directly benefit the people of Latin America. At the same time, he emphasized it would contribute to the ecology of the Western Hemisphere.

"Bringing the vampire under control means that cattle—an important source of human food—will receive urgently needed protection. It will also mean that the livestock producers in Latin America, many of whom are small farmers, will be able to increase their incomes, thereby improving their standards of living.

"The methods devised under this research program also mean that man, who had contributed to building up the number of vampire bats by furnishing them with an easy and accessible food supply, may now restore the ecological balance that has become increasingly distorted.

"We will not be eliminating the vampire bat by any means," Dr. Hannah said. "As harmful as the vampire may be in the present ecological imbalance, it is an interesting animal which, like all creatures, has a right to survive. It is a curiosity of nature, and with proper controls—as promised by this research—it can continue to live, but with a minimum of harm to man, domestic animals, and the environment."

Aid to Public Health

Erven J. Long, Director of AID's Office of Research and University Relations, noted that "in addition to reducing one of the obstacles that has hampered the Latin American livestock industry, thus playing a part in increasing food production and economic development, the control methods make a welcome contribution to public health by attacking a source of rabies.

"The ingenious methods and means that have been developed in this project are ecologically sound," he declared. "No other life—plant or animal—is endangered, not even that of other bat species. The control measures are directed only at bat colonies in specific areas, so even the vampire bats themselves are not endangered as a species.

"Finally, this project is a splendid example of successful, speedy and economical applied research. The total cost of the project is less than $800,000—about 3/10 of 1 percent of the annual damage of the vampire bat to the people of Latin America.

"A most remarkable thing is that, after starting practically from scratch, the research breakthrough comes after less than four years' work. This is extraordinary."

Nelson B. Kverno, the Research Center's coordinator for AID programs, recently recalled how the breakthrough came about.

"It seems like a simple thing looking back at it now," said Mr. Kverno. "But it wasn't when we started.

"First of all, very little was known about vampire bats. We knew there were three species of vampires, and that one of them—the *Desmodus rotundus*, called that because he puffs up when he has drunk the blood —seemed to be the one that primarily plagues livestock. The other two species feed primarily on birds or wild mammals and are not as widespread."

Mr. Kverno is a slight, 45-year-old biologist of serious mien, whose interest in wildlife stems from his boyhood days in the Lake of the Woods country of northern Minnesota. His enthusiasm for animals illuminates his conversation. He regards the vampire bat as a particularly interesting creature.

"The vampire bat," he says animatedly, "is really unique. He's a pest, but he doesn't meet the criteria of most pests, such as the Norway rat, house mouse or

starling. These adapt themselves well to the area they live in and are highly productive.

"The vampire bat is specialized," Mr. Kverno said. "The female usually bears only one young at a time, and the gestation period is five months. One birth a year is not uncommon. The vampire lives on blood alone, and apparently temperature, humidity, and other conditions must be in an exactly right combination within his roost or he cannot survive. The vampire is very secretive, and could be labeled a parasite compared to other bats which eat insects and feed on flower nectar, and are beneficial and harmless to man."

Man Has Contributed to Increase

Mr. Kverno said it is believed that the vampire bat was far less numerous before the coming of man, who has contributed to the animal's increase.

"Man moved in with his livestock. The vampire bat found a big, easy, slow-moving food supply, and was able to prosper, despite his slow reproduction and secretive habits. He has been associated with the Latin American cattle industry for a long time. The ranchers have considered the bat as part of the scene—something to endure—but the problem has been getting worse."

Although the vampire bat doesn't reproduce fast, Mr. Kverno said, he makes up for his slow pace by living a long time. Vampires have been known to live for as long as 12 to 13 years. Most small rodents live less than a year.

In order to learn more about the bat's life style, the Research Center set up a station at Palo Alto, Mexico, along with the Mexican Government's Instituto Nacional de Investigaciones Pecuarias. Work also was coordinated with the FAO and the World Health Organization.

Miniature radio transmitters were developed and attached to captured bats to monitor their movements when set free. The electronic signals wove a pattern of the bats' flights. Starlite night vision equipment was borrowed from the U.S. Army to observe the bats when they fed on cattle.

Some interesting information was obtained through study, lab and field work. Bats must feed at least every two or three days. They roost together and may return to the same roost, or to other nearby roosts. Other bats —not vampires—often share the same cave, but have no physical contact with the vampires. The vampires preen and groom themselves and each other assiduously. They prefer to fly in utter darkness.

"I remember one night in Brazil," Mr. Kverno said. "We were conducting a field test last January. We had set up the mist nets to catch the bats around a corral, then waited. Darkness came, but no bats. This was because the moon was up. We waited. Finally, about 2 A.M. the moon set, and out flew the bats from their cave. In 30 minutes we had 50 bats in the nets."

This type of patient observation, plus the laboratory research, led to various ideas of control. Some of them were adaptations of what had been tried already. Others were new.

"Eventually," Mr. Kverno said, "we came up with the systemic method—the injection of the anticoagulant into the cow"—and the topical method—the smearing of anticoagulant on a bat and the eventual contaminating of others using the same roost. (The researchers at Denver use the term "cow" for all cattle.)

Mr. Kverno said the injection method requires no new techniques. Veterinarians or ranchers can inject the anticoagulant into the rumen with a syringe in much the same way they inject serum or other medication.

The anticoagulant, diphenadione, enters the bloodstream of the animal. The vampire bat, when he bites, ingests the anticoagulant, along with the blood he draws from the cow. The anticoagulant affects the bat's liver and the clotting ability of the bat's blood is reduced to a fatal level.

Dr. R. D. Thompson, a 37-year-old physiologist at the Denver Research Center, who developed this procedure, recently explained what happens.

"The anticoagulant, once absorbed into the blood, temporarily binds to plasma protein. It blocks the bat's ability to utilize Vitamin K for synthesis of prothrombin, a blood factor necessary for normal coagulation."

"The flying action of the bat—he has a wingspread of 12 inches—tends to promote small capillary fractures or leaks in the thin membraneous wings and other areas of the body. If clotting is normal, these seal up, and the bat is unaffected. An anticoagulant, however, prevents the capillary leaks from sealing up. Hemorrhages result, and the bat dies.

Dr. Thompson is a native Oklahoman. "I enjoy working with cattle," he says, "because my academic training was in dairy cattle physiology." He began his study of ways to save Latin American livestock from the vampire bat in 1968.

Dr. Charles Breidenstein worked with him in the initial phases. Serving with him over the past four years have been biological technicians Stanley E. Gaddis and Gilbert Holguin. Holguin was familiar with vampire bats before the AID project began, having worked with them in a Bureau of Public Health rabies laboratory in New Mexico.

Other researchers who have been involved in the studies are Dr. Stephen A. Shumake, an animal behaviorist, and Mr. Roger Bullard, an analytical chemist. Dr. Nels Konnerup, livestock specialist in Aid's Technical Assistance Bureau, monitored this and other aspects of the project.

Consumes Own Weight in Blood

"Before we initiated the project," Dr. Thompson recalled, "we calculated the blood volume of the cow and the blood volume of the bat. We measured the amount of blood consumed by the bat—he drinks his weight (30 grams, slightly over an ounce) in blood every day—and, of course, kept in mind that the bat must feed at least every two or three days.

"It seemed evident that if we had a chemical that could be retained in the blood of cattle for as long as this period—up to 72 hours—this would be enough time for a bat to feed at least once. We might then have something."

There was some initial concern about bringing cattle on the premises of the Wildlife Research Center because of lack of proper facilities to care for large animals. Vampire bats are potential carriers of rabies and this also offered some concern to officials. The responsibility for going ahead with such research was not a light one.

In spite of this, holding pens for cattle were erected outside the bat laboratory. Also a holding pen was constructed inside the bat laboratory to simulate field conditions which would allow bats to feed directly from a cow. Because of concern that bats might escape from the laboratory, an inventory was maintained. The researchers wore heavy gloves and protective clothing. In the four years of experimenting and testing, not a bat was unaccounted for, although occasionally one did escape a technician in a room and fly around the lab. The lure of food—blood obtained from a Denver slaughterhouse—would bring it back into his cage. And no one in the lab was bitten.

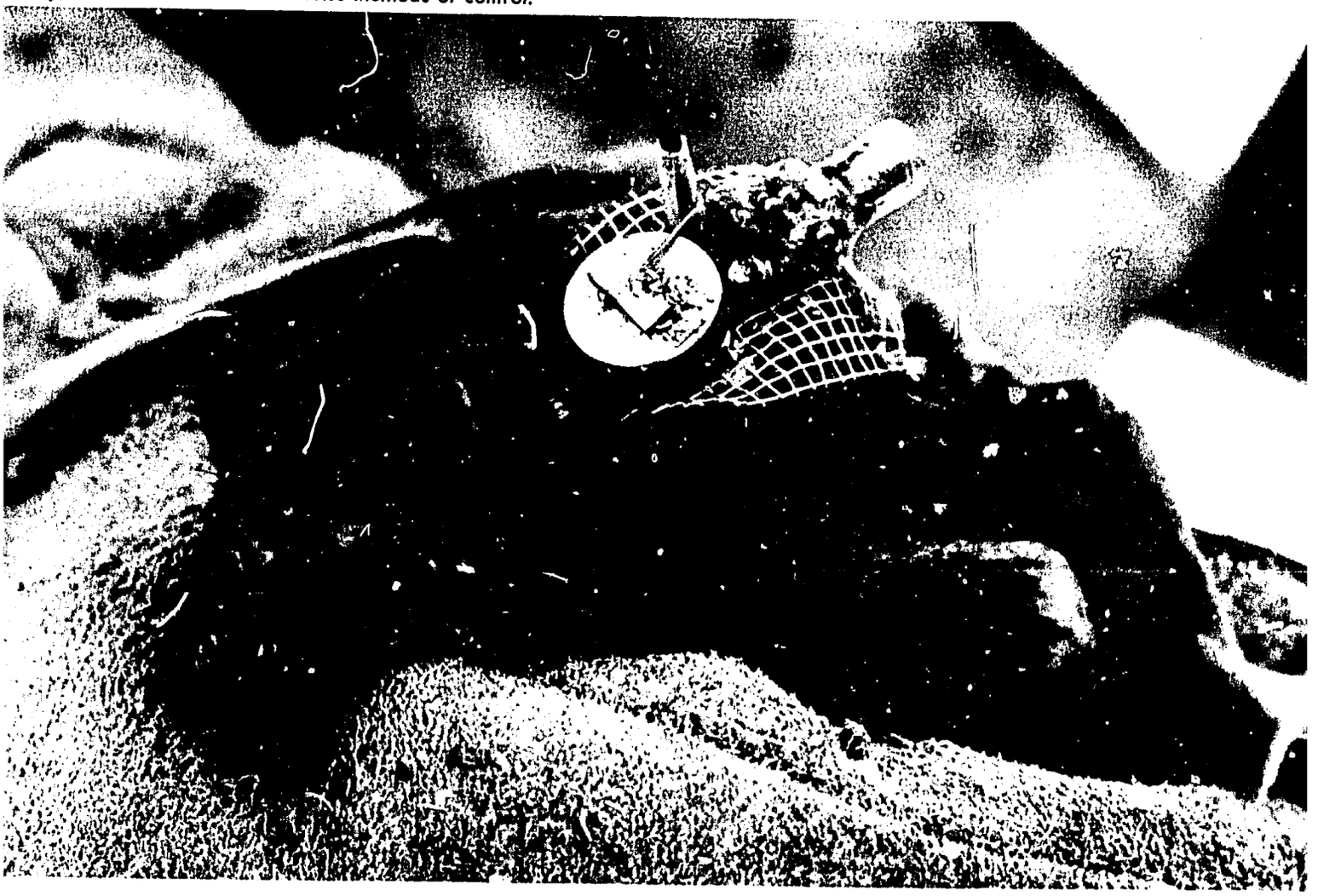
Observations of the bats' behavior led to some interesting findings, not all of which were immediately applicable to the project of finding a viable control technique. One of the questions raised in the laboratory was whether vampire bats feed on cattle because the livestock are available, or because of instinct.

"Occasionally, in some of the shipments of bats from Mexico, there would be pregnant bats and as a result some bats were born in the laboratory," Dr. Thompson said. "They had never fed on a cow. We put some of these lab-born bats in with a rabbit to see if they would bite it. They didn't. We think that the mother trains the young to feed on animals—an acquired behavior."

In another interesting observation, bats which hadn't had any artificial feeding were placed with rabbits. Within two to three weeks one of the rabbits died. An analysis showed it had rabies.

"We put the bat that had been feeding on the rabid victim in with another rabbit. The second rabbit didn't die. After awhile, we slaughtered this rabbit and examined it. It had no rabies. We are still wondering why the first rabbit had rabies and the second didn't. There is the question: Is it possible that the virus could be active once and not later? We don't understand the significance of this yet."

Miniaturized transmitters were specially designed to fit on the backs of the tiny creatures. By tracing the bat's movements electronically, scientists were able to devise methods of control.



In other observations and tests, it was found that the vampire bat has a very efficient digestion system for blood. While most animals must eat foods containing fats and carbohydrates, the vampire bat consumes only blood, which is almost exclusively protein. The bat's system is able to transform the nitrogeneous elements of protein into sufficient carbohydrate to support life satisfactorily.

The bats' senses of smell, taste and sight also were investigated. An ingenious "batmobile", a device to test the bat's echo-locating system, was devised by Dr. Shumake. The bat and a sensitive microphone are suspended from a frame which moves by gravity on pulley wheels running on an inclined cord. As the batmobile moves, the bat emits "beeps" at a frequency of 50-65 kilocycles per second which cannot be heard by humans but can be recorded. These beeps change in intensity as an obstacle, such as a wall, is neared. This may help to understand why a bat can fly so well in utter darkness. Vampire bats, however, do not seem to be as dependent on the echo system as other bats.

Intelligent But Stereotyped

"Observations in the laboratory indicated that the vampire bat is an intelligent animal," Dr. Thompson said, "but compared to the rat he exhibits stereotyped behavior. For instance, unlike the rat, he is not used to making food choices."

These and other studies of the vampire bat's physiology and behavior led to the conclusion that a temporary chemical treatment of cattle blood was a possible solution.

What the chemical agent might be was a matter for considerable discussion.

"One day," Dr. Thompson remembered, "I overheard a biological laboratory technician mention an anticoagulant known as chlorophacinone, which was used for rat and mice control. It was also found to be toxic to bats.

"Our initial pilot research was conducted with sheep. Sheep have a four-compartment stomach like cattle, and their digestive system is like a cow's.

"We dosed sheep with chlorophacinone; then took blood and fed it to the bats. It killed them.

"However," Dr. Thompson added, "we later found when working with cattle that this anticoagulant tended to bind in the liver 20 days after dosing. This is too long. Whatever we used must not cause permanent residue in the host animal. We felt we couldn't go further with this anticoagulant, but we believed we were on the right track."

Dr. Thompson and his staff then switched to another anticoagulant — diphenadione. This anticoagulant worked effectively on the host animals with no harmful side effects. In addition to its use in human medicine, this anticoagulant is used as a rodenticide. The only difference from the other is that it does not contain chlorine, which, it was thought, caused the prolonged binding.

Field tests proved the success of the anticoagulant. Typical were those conducted on three adjoining ranches in the State of San Luis Potosi, Mexico. In one experiment the anticoagulant was injected into 207 head of cattle; 214 fresh vampire bat bits were counted. Two weeks later, the number of fresh bites was down to 15, a reduction of 93 percent.

As for the effect on cattle, the livers of two beef calves slaughtered 30 days after injection of the anticoagulant were fed to laboratory rats. Since the liver is the site of action as far as this anticoagulant is concerned, it should reveal toxic symptoms if any anticoagulant residue existed. After seven consecutive days of eating the liver—a diet amounting to the human equivalent of 15 pounds of food daily—none died.

Similarly, according to Dr. Thompson, there seems to be no real hazard to consuming the milk of lactating cows treated with a single dose of the anticoagulant. In an experiment with three cows and their three nursing calves there was no discernible toxicity during the period the anticoagulant is in a cow's system.

There are a number of advantages to the systemic procedure, according to Dr. Thompson.

- There is no human contact with the bat.
- It is highly specific; only the vampire bat is adversely affected.
- It capitalizes on two vulnerable physiological areas of the bat; the concentrating effect of the anticoagulant on the bat's body, and the bat's sensitivity to the anticoagulant.
- The dosage received by the cattle is safe; at least five times the amount sufficient to kill the bat would be required to make the cattle's blood toxic. Vitamin K is an effective antidote but it is not needed in this case.
- The anticoagulant treatment can be given rapidly by a veterinarian to corralled animals or in a chute.
- The treatment can be fitted into a livestock managerial program and to a large scale bat control program.

While the vampire bat's unusual physiological make-up provided the clues to one method of controlling him, his fastidious habits are responsible for making possible the second way.

Samuel B. Linhart, 39, a bearded, pipe-smoking biologist, developed the second successful method for controlling the vampires—the topical technique. He was the first researcher on the project to set up a field station in Mexico, and as such spent considerable time in caves observing the home life of the bat.

"We lacked considerable information about the vampire bat at that time—June 1968," he said. "We felt we had to learn more about the way this animal functioned and lived before we could develop control techniques.

"We found that the vampire bats groom themselves intensively. They groom each other, too, and in the roost are always in close contact with each other. They

Anticoagulant mixed with petroleum jelly is smeared on bat's back.

will spend two to three hours a day grooming and scratching. The individual bat will scratch his body rapidly with one foot, then insert the foot in his mouth every five or ten seconds. He will clean his wing membrane and thumbs with his tongue."

Through closed circuit television, Mr. Linhart and his staff observed their grooming habits and found that at least one-third to one-half of a captive colony of bats would be grooming at any one time. Not only would they nestle up to each other, but one would occasionally fold his wings over another. They would lick each other with their tongues.

"This indicated," Mr. Linhart said, "that any material adhering to the body of one of a colony would promptly be spread to and ingested by others."

Mr. Linhart said, however, that the idea of using this principle came only after what he called a "wild idea."

"We were discussing possible new methods of control and someone suggested attaching a bomb to a bat that would later explode back in their roost," he said. "Then we got to thinking of putting a little gas capsule on one bat. Its discharge would affect the whole colony when the bat returned to the roost. But we never tried these.

"In any case," Mr. Linhart said, "the bats' behavior as we had observed in the field and in the laboratory indicated that if a slow-acting anticoagulant could be applied to a few vampires, the whole colony could be contaminated.

"At one point we thought of applying the anticoagulant to the cow so that the bat would walk through it when he made his bite. We then got the idea of using mist nets, which we knew to be effective, to trap a few bats at the cattle corral or outside the roost, smear the anticoagulant on their backs, and release them. They would fly back to the roost and the grooming and preening would take care of the ingestion."

Different chemicals were tested to find the right type and quantity. The advantage of an anticoagulant is that it is slow-acting, permitting it to be effective for eight to 15 days, time to contaminate the whole colony. A fast-acting chemical might lose its effectiveness before all the bats ingested it.

"We were concerned about killing beneficial species," Mr. Linhart said. "However, in our field tests we found that a different species of bat, although roosting in the same cave, would not associate with the vampires and would not be affected. We never found any other species dead from ingesting the chemicals we used in our tests."

Sought Suitable Carrier

The first anticoagulant used in the tests was chlorophacinone, but it was later found that the American-made diphenadione was superior. Besides, Mr. Linhart said, it is not so much the anticoagulant as the method of applying it that was the important development.

Tests were run to select a suitable carrier. An acetone paint pigment mixture was successful in spreading the anticoagulant. The mixture, however, gradually powdered and flaked from the back of the treated bat. Although making for uniform distribution, this resulted in considerable loss of the mixture. Petroleum jelly, mixed with the anticoagulant to form a paste, finally was selected as the best carrier. It adhered better to the bat's fur.

To obtain the bats that would carry the anticoagulant back to the roost, mist nets were found to be the most suitable. Made of fine nylon mesh, they are commonly used to snare birds. The mist nets can be erected around corrals or caves before dark and when the bats fly at night, a number become entangled. The anticoagulant paste can then be applied.

Early in the tests with mist nets in Mexico, Mr. Linhart and his group ran afoul of some suspicious farmers near the village of Chilpancingo.

"We were about 15 miles outside the village," Mr. Linhart recalled. "We put up the mist nets hoping to catch some bats, then parked the Jeep farther up the road. We checked the nets every 10 or 15 minutes. A Mexican biologist was with me and when he was returning to the Jeep one time he found himself surrounded by about 20 men carrying guns and machetes.

"They then came for me and marched us into the village while one of them drove the Jeep. My Spanish wasn't very good then, and I couldn't understand what they were talking about. However, the mayor of the village told the Mexican biologist that bandits had been operating in the area and the farmers had thought we were using something strange and new to rob them.

"We finally convinced them we were scientists. After all that, we caught only one bat in the nets."

Once, in exploring a cave on a ranch, Mr. Linhart and his party discovered an underground river that no one on the ranch had been aware of. They netted some blind fish from the river which were sent to German scientists who later visited the river to collect blind live fish for shipment back to Germany.

Look Who Was There!

"Sometimes, exploring caves had its amusing side," Mr. Linhart said. "In one remote area, there was a legend of hidden gold in a certain cave. We hired a German blacksmith who lives in the area as a guide.

"The cave's opening in the side of a mountain certainly looked like a place someone would choose who wanted to hide gold. We crawled in and it looked as if no one had ever set foot there. We penetrated further but saw no sign of any hidden gold or anything else. Then we did find something. Scratched on the wall was: 'CIA was here!' I never did learn how that got there."

Mr. Linhart's exploration, observations and tests eventually evolved into successful experiments. In one laboratory test, a single bat was treated with the anticoagulant paste and released into a cage with 19 other bats.

In one day the treated bat died. On the second, third and fourth days, no bats died, but on the fifth day, four were dead. Another died on the sixth day, and five more on the seventh. Within 14 days, 19 of 20 were dead—victims of internal hemorrhaging caused by the anticoagulant.

Field tests conducted in two caves in the state of Morelos in Mexico brought similar results. In one cave where 50 to 60 vampire bats roosted, 6 were netted, treated with the paste, and released.

Eight day later, there were only 12 to 15 bats still living, but their behavior indicated that the anticoagulant had been ingested. Normally, bats try to hide by flying, hopping or crawling when disturbed. All but one were unable to flee. In 14 days, one bat remained alive.

In a cave harboring a larger colony, 13 bats were trapped and banded. Six of these were treated with the anticoagulant paste and released. Fourteen days later, investigators found 94 dead bats, and only one alive.

In the Mexican tests, chlorophacinone was used. In tests in Brazil last January, diphenadione was used. On two ranches there was 100 percent reduction in fresh bites by vampire bats within a two-week period, and a 96.6 percent drop at a third ranch.

Pros and Cons

Mr. Linhart summed up several advantages of the technique he developed:

- Only a few bats need to be treated in order to control all in a colony.
- The cattle are not involved. The toxicant directly affects the vampires with no intermediate process.
- If several ranches are afflicted by a colony of vampire bats the colony can be eliminated without the necessity of all ranchers agreeing to injections.
- A veterinarian is not required.

On the other hand, the topical method developed by Mr. Linhart requires a certain amount of training on the part of those who erect the mist nets and apply the anticoagulant. The injection method requires only a veterinarian or rancher who already knows how to give an injection.

There is also the danger of a control worker being bitten, and the inconvenience of having to do the netting of the bats at night.

"Both methods are effective and one or the other can be fitted into a control program, depending on circumstances," Mr. Kverno summed up. "It is likely, however, that the injection method will be used more than the other."

In addition, G. Clay Mitchell, another member of the Research Center Staff, is working on other techniques at the Palo Alto Station.

If the techniques already developed for controlling the vampire bat are implemented—and Mexico, Brazil and other countries are planning programs using the new methods—does this mean the end of this strange and repulsive animal?

"Certainly, the vampire bat contributes very little—if anything—to life," Mr. Kverno said, "but man's curiosity about his world and the living things in it is enough reason for wanting the vampire bat to survive. Besides, we'd be naive to think we could eliminate it entirely with these methods. Actually cattle are found in only a small portion of the vampire's total range in Latin America.

"What AID and we are seeking to do is to help the Latin American countries reduce the number that prey on livestock. We are seeking to manage the numbers that live in the cattle-rearing areas.

"There is no possibility of eliminating the vampire bat altogether. He will be with us for a long time to come, but hopefully not so harmful."